FUNCTIONAL ASPECT OF THE INTROMITTENT ORGANS OF NON-TIBIAROLIATE ASSASSIN BUGS, HETEROPTERA:REDUVIIDAE[1]

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(*With three text-figures and one plate*)

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The male intromittent organs of Harpactorinae, Stenopodainae, Emesinae, Saicinae and Holoptilinae have been structurally and functionally analysed.

INTRODUCTION

In Reduviidae, the morphology of the male genitalia has been so far studied merely to add to taxonomic descriptions. The only description, providing a limited understanding of the functional morphology of male genitalia in Reduviidae was given for *Rhodnius prolixus* by Davey (1959), with special reference to spermatophore production. He coined the term "Spermatophore sac" for the first time to describe a much folded membranous sac composed of the aedeagus and endophallus. Such a sac has been described as composed of two layers of cuticle bounding a blood space, the inner wall being the endophallus and outer wall the aedeagus. This spermatophore sac, therefore, was described as a sac composed of aedeagus on the exterior and the endophallus lining the lumen. The external opening of the spermatophore sac through which the spermatophore is finally released was named by Davey (1959) as the phallotreme meaning gonopore (GP) corresponding to the secondary gonophore of Lent and Jurberg (1978).

The taxonomic value of the phallus of Reduviidae has been highlighted by Davis (1966), Lent and Jurberg (1966, 1978 & 1980), Popov (1971) and Wygodzinsky and Lent(1980). While the male genitalia was considered useful to taxonomy only at the suborder level by Popov (1971), Cobben (1978) believes that they provide the strongest evidence on macroevolution, when examined at all levels within each group.

MATERIAL AND METHOD

The male genitalia of various species of assassin bugs have been studied from dried and preserved specimens. The genital segments were severed and boiled in 5% potassium hydroxide solution for 5 minutes and then washed in dilute acetic acid and stored in glycerine. These stored materials were dissected, cleared in clove oil and mounted in polyvinyl lactophenol. Complete expansion of the invaginated endosomal structures can be achieved by applying gentle pressure to the abdomen of live, sexually active males and the evaginated expanded endosoma can be severed.

RESULTS AND DISCUSSION

The aedeagus is a highly complicated, extensible chitinous sac of the intromittent organ, enclosed within the inner capsule of the pygophore. The pygophore is heavily sclerotised, both ventrally and mid-dorsally, but for a narrow membranous strip at the anterior border. It is

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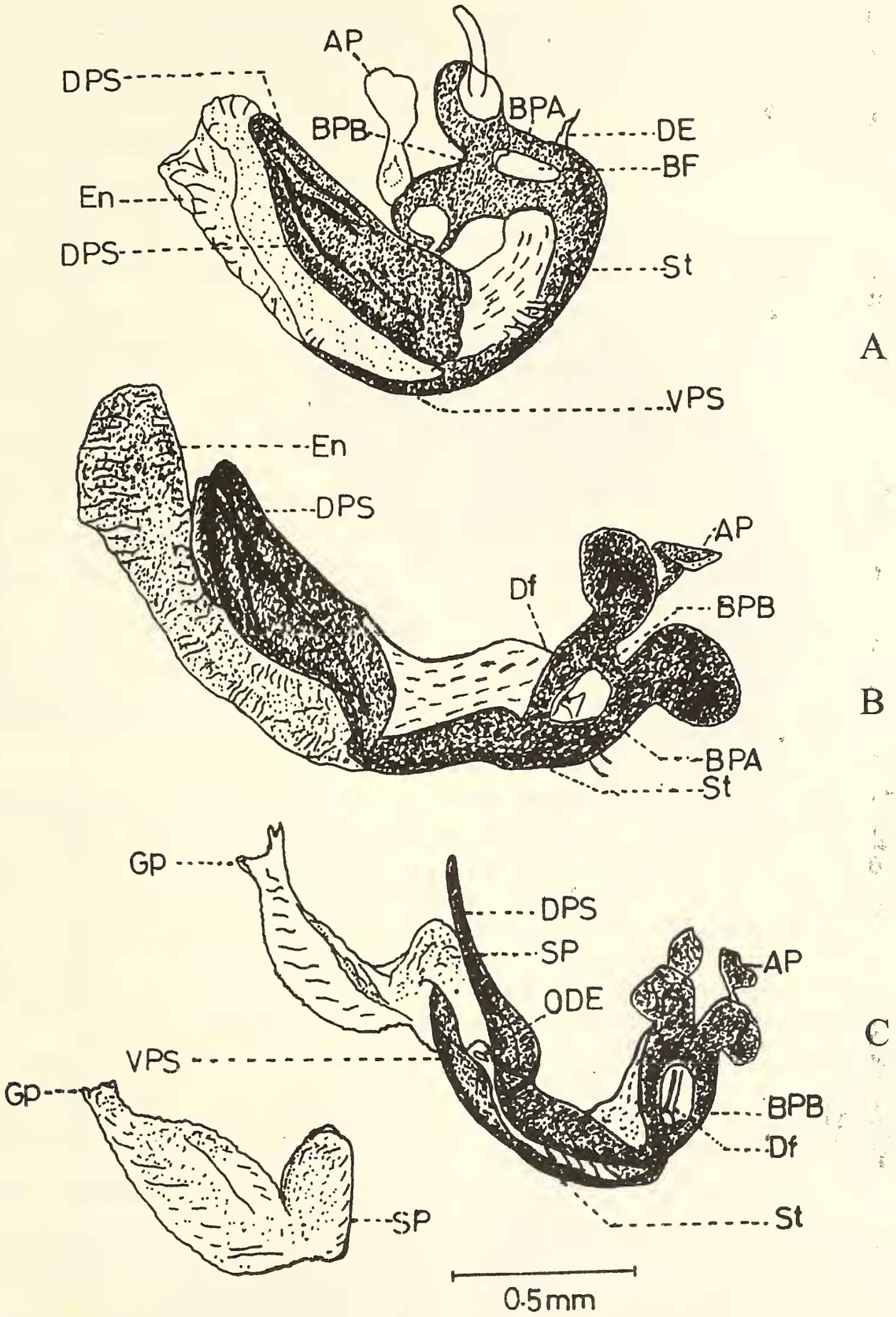


Fig. 1: A-D. Intromittent organ in action; A: *Bardensanes sericenotatus*; B: *Oncocephalus klugii*; C: *Diaditus errabundus*.

AP: Apodemes, BF: Basal Plate Foramen, BPA: Basal Plate Arm, BPB: Basal Plate Bridge, DE: Ductus ejaculatorius, Df: Ductifer, DPS: Dorsal Phallic Sclerite, En: Endosoma, GP: Gonopore, ODE: Opening of Ductus ejaculatorius, SP: Spermatophore Pouch, St: Strut, VPS: Ventral Phallic Sclerite.

highly membranous, and is in turn covered by the proctiger. Posteriorly, the membranous part becomes sclerotised into a vertically hanging suspensory plate on either side, leaving a narrow longitudinal slit in the middle to allow the enclosed aedeagus to emerge at the time of copulation.

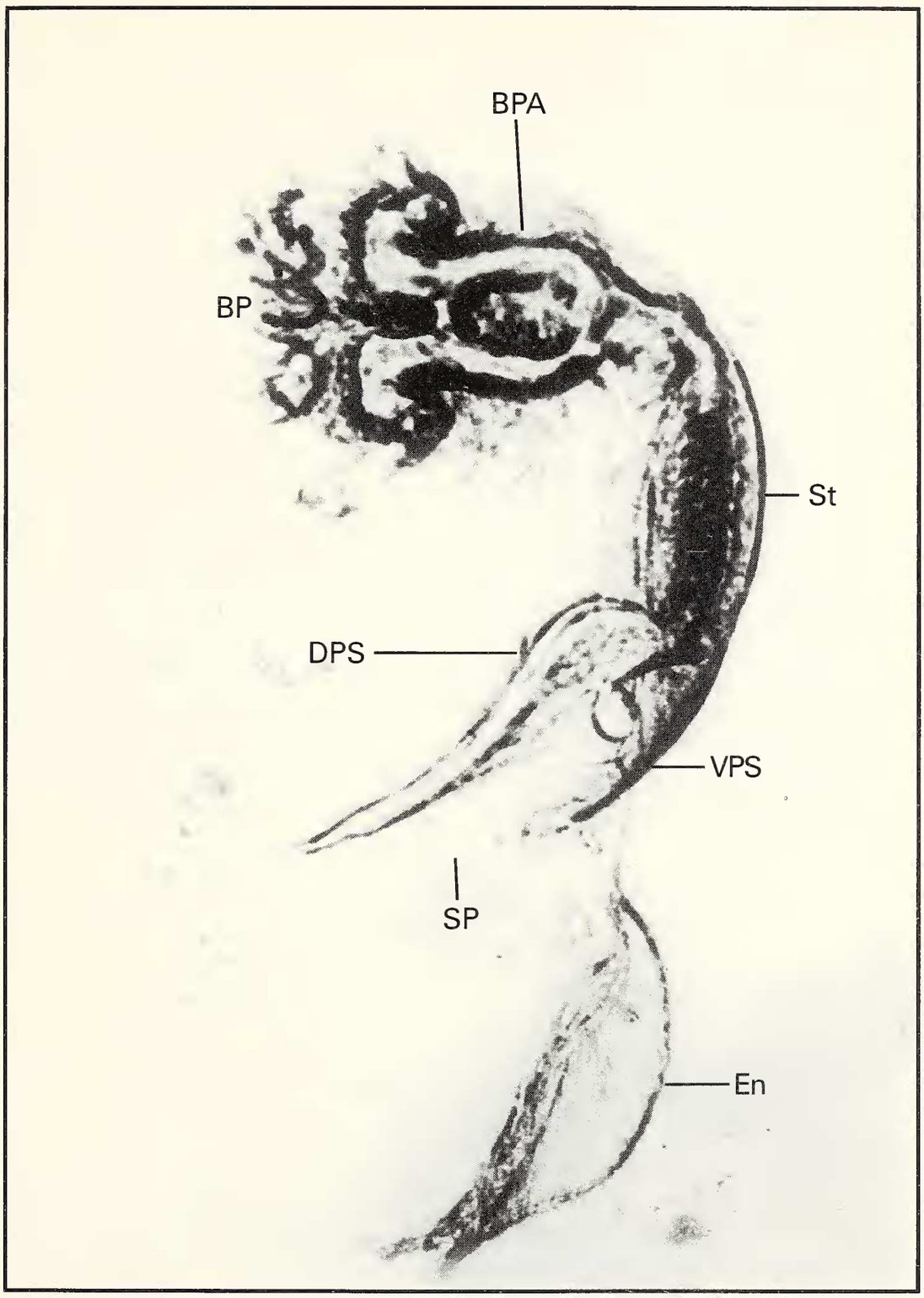
The intromittent organ in Reduviidae has been described as the basal plate and the aedeagus, since the former plays a crucial role in conveying the sperm. It catapults the aedeagus in the process of transmission of spermatophore, to lodge the same in the bursa copulatrix. Therefore, it is considered a part of the intromittent organ. It is consistently provided with two powerful arms, each arm terminating in the form of a disk that supports the apodemes (AP) bearing the tendons of all the extensor muscles that are involved in the catapulting mechanism, and a strut that hinges with the aedeagus dorsally. The strut normally remains concealed by the aedeagus. In the resting position both arms (BPA) lie on either side of it, in close proximity. Both arms may or may not be connected by a cross bar — the bridge (BPB). When the bridge is present, it establishes a fossa — the basal plate foramen (BF). In the absence of a bridge, the basal plate remains a Y-shaped structure. The ductus ejaculatorius (DE) enters the intromittent organ at the base of the strut (St) and then runs through the groove, throughout its length, to open into the spermatophore pouch (SP) that develops at the junction of the aedeagus and the basal plate.

Recognition of various structures of the reduviid phallus and description of their variations are most complicated, according to Kumar (1962). By his studies on the male genitalia of many reduviids, he has recognised three types of endosomal sclerites, corresponding to the "Phannaries" of Villiers (1948). The dorsal phallic sclerite has been described by him as the basal plate strut. The bulbus ejaculatorius as the stalk of the basal plate sac and the dorsal surface of the phallotheca was recognised as the ventral surface. While all the other workers, including Villiers (1948), Kumar (1962), Matsuda (1976), Cobben (1965, 1978), Giacchi (1969), Popov (1971), Lent and Jurberg (1966, 1978, 1980), Dupuis (1955, 1970) and Wygodzinsky and Lent (1980) described the endosoma as a bipartite structure, comprising of the conjunctiva and the vesica, Davis (1966) emphasized that the endosoma is an eversible, erectile tube, not divisible into conjunctiva and vesica. In that respect, Davis (1966) is more correct in describing a generalised type of reduviid phallus and his emphatic declaration is confirmed by the present observation.

In the case of Harpactorinae, the endotheca is highly extensive and the pressure required to expel the endotheca in the act of copulation will be much more than in other species, especially of the subfamilies Emesinae and Stenopodainae in which the foramen is narrow. Here, the endotheca is less folded and more anteriorly located due to the forward extension of the strut of the basal plate, and the spermatophore pouch is obviously located at the basidorsal area of the endotheca.

In Stenopodainae and Saicinae, the extension of the basal plate strut at the expense of the ventral phallic sclerite (VPS) has caused the shifting of the dorsal phallic sclerite (DPS) far anterior to the basal plate foramen and invariably hinged with the basal plate strut, a little behind its apex. The ductus ejaculatorius, in turn, is distended throughout the length of the basal plate groove to open into the spermatophore pouch, which is invariably located in all species at the site where the dorsal phallic sclerite is hinged to the strut. In all cases, the endophallus remains considerably shorter, with least foldings. Therefore, it is reasonable to suggest that the extent of development of the basal plate strut and its fusion with the considerably abbreviated VPS could be correlated with the simplication of the endophallus. In Stenopodainae, in all the species examined, including *Bardesanes sericenotatus, Oncocephalus klugii,* and *Diaditus errabundus* (Fig. 1C), the bridge

Ravichandran, G. *et al.*: Intromittent organs of assassin bugs PLATE 1



Intromittent organ of Reduviid assassin bugs.
BP: Basal Plate, BPA: Basal Plate Arm, DPS: Dorsal Phallic Sclerite, SP: Spermatophore Pouch, St: Strut, VPS: Ventral Phallic Sclerite.

lies far behind the head and foramen. Therefore, it is considerably abbreviated.

In Emesinae and Holoptilinae, the fusion of the basal plate and intromittent organ has reached the fullest extent, so that it is difficult to disengage the various components even after treating in KOH for a prolonged period.

Functionally, the aedeagus could be divisible into the proximal cup-shaped phallosoma and a distal, highly elastic, distensible denticulate endosoma (En), that is withdrawn into the cup. The wall of the phallosoma cup has characteristic sclerotisation that appears to be species-specific and the dorsal wall of the cup is invariably much sclerotised. The sclerotised dorsal wall is termed as the dorsal phallic sclerite (DPS) that articulates with the strut of the basal plate. It is at this point of articulation that the sperms from the ductus ejaculatorius enter the pouch of the endotheca into which the spermatophore capsule is moulded. At repose, the aedeagus at its junction with the strut of the basal plate turns back and lies on its dorsal side, with the dorsal phallic sclerites closely approximating the inner surface of the basal plate strut. In this position the DPS and VPS remain opposed to each other, like the beak of a bird, the VPS lying dorsal to the DPS, often flanked by the two wings of the latter. In this position, the endosoma has its exterior opening directed anteriorly closely shielded by both DPS and VPS.

The endosoma that develops from the rim of the cup of the phallosoma remains highly folded and variously sclerotised with extensive denticulate armature. When it remains enclosed within the cup, it has its basidorsal region folded in the form of a pouch, into which the ductus ejaculatorius conveys its spermatozoa and accessory gland secretion, and the pouch provides the mould for the formation of the spermatophore capsule. Dorsally, the pouch presses against the inner surface of the DPS, and ventrally against the rest of the endothecal wall, while basally it communicates with the lumen of the endotheca itself.

At repose, the mouth of the pouch lies opposed to the junction of the basal plate strut and the DPS at which the ductus ejaculatorius opens and spermatophore is formed within this pouch. At the time of copulation, when the protractor muscles of the basal plate contract, the arms of the basal plate are pulled back, causing the strut to exert a torsion that catapults the aedeagus outward from its original reverse position. This is followed by pushing of the endotheca outward. Further, this tilting causes the basidorsal pouch or spermathecal pouch of the endotheca to rotate at an angle of 180°, so that the mouth of the pouch lies in a straight line with the lumen of the endotheca, and the spermatophore is released to be trans-ported further through the endosomal tube and lodged inside the bursa copulatrix. Clearly, the initial catapulting of the aedeagus results from the tilting of the basal plate, brought about by its extrinsic muscles and the extension of the endotheca is further brought about by the haemocoelomic fluid pressure, through the basal plate foramen. The endotheca is guided into the gonopore of the female by the pygophore spine that assumes a more vertical position, consequent to the tilting of the pygophore capsule.

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